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WORK OF THE SHERIDAN FIELD STATION FOR THE SEVEN YEARS FROM 1917 TO 1923, INCLUSIVE

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INTRODUCTION

The Sheridan Field Station is one of a group of 24 stations at which the Office of Dry-Land Agriculture Investigations has studied the possibilities and methods of crop production on the Great Plains. It is located 8 miles northeast of Sheridan, Wyo., about 10 miles south of the Montana-Wyoming State line, and about 15 miles east of the Big Horn Mountains. It was established in 1916, when buildings were erected and ground broken for crops. With the exception of a small field of sorgo grown for feed in 1916 the first crops were grown in 1917. Varietal, rate-of-seeding, and date-of-seeding tests were productive of results in 1917, but as the land was given uniform treatment in preparation for the crop that year the experiments with crop rotations and tillage practices were not productive of results until 1918.

The station occupies 160 acres of State school land leased by the Wyoming State Land Board to the United States Department of Agriculture for an experiment station and 3 acres purchased by the Wyoming Board of Farm Commissioners, in cooperation with which board the station was started. The functions of the board have been transferred to the University of Wyoming, and the cooperation is now with the agricultural experiment station of that institution.

The station is representative of a large area immediately east of the Big Horn Mountains. Numberless small streams and creeks drain this territory in a general northerly direction to the Yellowstone River in Montana. Most of these streams have valleys of considerable width, with good farming land extending back to the

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foothills. A considerable part of this land is irrigated, but much of it is so situated that water for this purpose can not be readily obtained. Large areas of tillable land also are found in the high land away from the streams. In general, the altitude of the farming land ranges from 3,400 to 5,000 feet.

The native vegetation is fairly representative of the area and very similar to that found on other portions of the northern Great Plains. The more common grasses include buffalo grass (*Bulbilis dactyloides*), blue grama (*Bouteloua gracilis*), western wheatgrass (*Agropyron smithii*), and needle grass (*Stipa comata*). Grasses predominate in the vegetation, but in addition to them sagebrush (*Artemisia* spp.), many legumes, and other herbaceous plants are found.

The greater part of the station is on a northeast slope, which is fairly uniform. Two small drainage courses passing through the land make a small portion of it unsuitable for experimental purposes. Narrow strips on the north and east sides are rough and unadapted to experimental work. The soil of the southern half of the farm is a dark heavy clay loam with a small quantity of gumbo. That of the northern half is lighter and more friable.

CLIMATE

The Sheridan Field Station records of the monthly, seasonal (April 1 to August 31), and annual precipitation for the seven years from 1917 to 1923, inclusive, together with the averages for that period are shown in Table 1.[1] Averages also are included for the Sheridan station of the United States Weather Bureau for the same period and for the 31-year period from 1893 to 1923, inclusive. Table 1 also gives the average monthly precipitation at Verona and Gillette, Wyo., for April to August, inclusive, for the 7-year period from 1917 to 1923, inclusive. This affords a general comparison of the rainfall at the experiment station and in the surrounding area and shows that the experiments have been conducted under conditions of rainfall fairly representative of the area.

Wide fluctuations have occurred both in the quantity of annual rainfall and in its distribution during the season. A study of the records of rainfall and crop yields shows the distribution of the precipitation to be a most important factor with respect to crop production. A small annual rainfall well distributed throughout the growing season will often result in better crops than a much larger rainfall poorly distributed. The total precipitation in 1920 was comparatively low, but the greater part of it was well distributed during the growing period, and the year was one of the best for crops that has been recorded.

Daily records of the evaporation from a free water surface from April 1 to September 30 are made each year. The evaporation is dependent upon various factors, including temperature, wind, and humidity of the atmosphere, and constitutes a fair index of the climatic factors other than rainfall influencing crop production. Evaporation tends to vary inversely with the precipitation, and at Sheridan it has ranged from 1.51 times the precipitation during the same period, in 1923, to 8.2 times the precipitation, in 1919.

The mean temperature from April 1 to September 30 averaged 59.5° F. for the 7-year period from 1917 to 1923, inclusive. Tempera-

[1] The climatic data at the Sheridan Field Station have been obtained in cooperation with the Biophysical Laboratory of the Bureau of Plant Industry.

tures of 100° F. or more occur but seldom during a season and frequently not at all.

TABLE 1.—*Monthly, seasonal, and annual precipitation at the Sheridan Field Station for the 7-year period from 1917 to 1923, inclusive, the average for the same period from the United States Weather Bureau record at Sheridan, the 31-year average for Sheridan, and the 7-year seasonal averages at Verona and Gillette, Wyo.*

Station and year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Seasonal, April to August	Annual
Sheridan Field Station:														
1917	0.84	0.37	1.31	0.63	3.84	1.36	0.09	0.43	0.08	1.02	0.08	0.78	6.35	10.83
1918	1.56	.08	1.65	2.92	3.18	1.54	1.16	1.02	2.60	.80	.60	.15	9.82	17.26
1919	.26	.23	.21	.94	1.01	1.12	.77	.30	1.16	1.80	.62	.14	4.14	8.56
1920	.46	.38	.49	2.35	2.68	3.11	1.11	.56	.45	1.13	.60	.32	9.81	13.64
1921	.44	.02	.65	.94	2.08	2.63	1.41	.30	.35	.21	1.38	.20	7.36	10.61
1922	1.27	.19	.35	2.63	2.82	3.48	3.12	1.27	.15	1.26	.82	.59	13.32	17.95
1923	.41	.22	1.34	2.37	1.95	2.94	3.45	.85	9.35	1.54	.43	.33	11.56	25.18
7-year average	.75	.21	.86	1.83	2.51	2.31	1.59	.68	2.02	1.11	.65	.36	8.92	14.88
Sheridan Weather Bureau:														
Average, 1917 to 1923	.94	.37	1.25	2.29	2.82	1.57	1.84	.85	1.86	1.38	.73	.64	9.37	16.54
Average, 1893 to 1923	.89	.70	1.19	1.72	2.72	1.92	1.23	.76	1.49	1.03	.63	.62	8.35	14.90
Verona:														
Average, 1917 to 1923	------	------	------	1.71	2.63	1.72	1.36	.74	------	------	------	------	8.16	------
Gillette:[1]														
Average, 1917 to 1923	------	------	------	1.79	1.84	2.91	1.72	2.07	------	------	------	------	10.33	------

[1] Record not complete for all months of the seven years.

The average wind velocity is relatively low for the Great Plains. Winds causing destructive soil blowing are of rare occurrence.

The station records of evaporation, temperatures, and wind velocity are given in Table 2. The evaporation was recorded in daily micrometer measurements of the change in the water level in a tank 24 inches deep and 6 feet in diameter sunk to a depth of 20 inches in the ground. The temperatures were recorded in a standard Weather Bureau shelter. The wind velocity was measured by a Robinson cup anemometer exposed at a height of 24 inches.

The average frost-free period for the seven years specified was 131 days. The earliest killing frost in the fall was August 29, 1920. A large part of the surrounding country was not frosted at that time. The earliest date of killing frost in the other six years was September 11, and in four of the seven years there was no killing frost until well into October. Weather during the fall generally is quite favorable for taking care of field crops. Frost data recorded

at the Sheridan Field Station during the seven years from 1917 to 1923, inclusive, are given in Table 3.

TABLE 2.—*Monthly evaporation, mean temperature, and mean wind velocity at the Sheridan Field Station from April to September, inclusive, for the seven years from 1917 to 1923, inclusive*

EVAPORATION (INCHES).

Year	April	May	June	July	August	September	Seasonal, April to September
1917	3.139	4.909	5.819	9.810	7.850	5.138	36.665
1918	2.948	4.181	6.368	6.694	7.503	3.873	31.567
1919	3.563	6.899	8.976	10.297	8.770	5.158	43.663
1920	2.100	4.128	5.255	6.754	7.152	5.083	30.472
1921	4.599	4.715	7.045	9.647	7.922	5.310	39.238
1922	2.659	4.275	6.031	5.980	6.610	5.531	31.086
1923	2.766	4.655	5.327	7.846	5.635	5.352	31.581
Average	3.111	4.823	6.403	8.147	7.349	5.064	34.897

MEAN TEMPERATURE (° F.).

1917	40	50	59	73	65	59	
1918	38	52	68	69	68	56	
1919	46	57	71	75	72	60	
1920	36	52	61	69	68	58	
1921	43	54	68	73	70	54	
1922	40	53	65	67	72	61	
1923	41	55	62	74	66	58	
Average	41	53	65	71	69	58	

WIND VELOCITY (MILES PER HOUR).

1917	5.9	6.4	5.2	4.3	4.2	4.4	
1918	6.8	5.0	3.9	3.4	3.8	3.5	
1919	5.9	6.1	6.1	5.3	3.5	2.0	
1920	6.1	6.0	4.1	2.8	3.7	3.3	
1921	7.4	6.4	5.2	4.7	4.3	6.7	
1922	6.0	6.6	2.7	2.1	2.2	2.3	
1923	4.7	5.2	4.1	3.7	3.0	3.8	
Average	6.1	6.0	4.5	3.8	3.5	3.7	

TABLE 3.—*Dates of the last frost in spring and the first frost in the fall and the number of frost-free days at the Sheridan Field Station for the seven years from 1917 to 1923, inclusive*

Year	Last frost in spring	First frost in fall	Frost-free period (days)
1917	June 1	October 8	129
1918	May 27	October 18	144
1919	June 22	October 9	109
1920	April 26	August 29	125
1921	May 13	September 11	121
1922	May 12	September 30	141
1923	May 16	October 12	149
Average	May 21	September 29	131

ROTATION AND TILLAGE EXPERIMENTS

The experiments with crop rotations and tillage methods occupy 240 tenth-acre plats. Of this number, 204 plats were started in 1917 and 36 in 1920. The crops grown and the number of plats

annually devoted to each are winter wheat, 25; spring wheat, 39; oats, 54; barley, 10; corn, 48; flax, 13; sorgo, 4; alfalfa, 3; brome-grass, 3; rye for green manure, 4; field peas for green manure, 5; sweet clover for hay, 2; sweet clover for green manure, 3; and potatoes, 1. The plats summer tilled or fallowed number 26 each year. Included in the cropping system are 51 rotations, 6 continuously cropped series of 6 plats each, 2 plats continuously cropped and stubbled in each year, and a series of 8 plats consisting of tests of methods of fallow with spring wheat. Six rotations are duplicated in different parts of the field.

The rotations vary in length from two to six years, the various lengths being represented as follows: Ten 2-year, twenty-four 3-year, eighteen 4-year, two 5-year, and three 6-year rotations, including the duplicates. The average yields of all plats of each crop for the 6-year period from 1918 to 1923, inclusive, are shown in Table 4.

TABLE 4.—*Annual and average yields of each crop in the experiments with crop rotations and tillage methods at the Sheridan Field Station for the six years from 1918 to 1923, inclusive*

Year	Winter wheat	Spring wheat	Oats	Corn		Barley	Flax
				Grain	Stover		
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Pounds*	*Bushels*	*Bushels*
1918	34.8	24.8	57.4	32.2	2,607	37.9	12.8
1919	1.7	1.4	.4	0	236	.5	0
1920	28.0	23.6	52.0	17.3	1,730	39.5	7.1
1921	10.3	6.3	8.1	.6	1,276	3.1	0
1922	27.1	29.5	48.9	23.0	1,835	47.4	10.4
1923	17.7	21.6	46.4	38.9	2,126	25.0	6.7
Average	19.9	17.9	35.5	18.7	1,635	25.6	6.2

Year	Sorgo	Alfalfa		Brome-grass		Sweet clover	Potatoes
		Second year	Third year	Second year	Third year		
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Bushels*
1918	6,200	2,250	2,400	3,050	2,500	----------	----------
1919	480	0	0	270	0	----------	0
1920	4,900	1,570	2,180	0	1,770	----------	----------
1921	1,830	0	580	160	320	450	8.0
1922	4,788	0	2,420	[1] 0	0	----------	120.8
1923	5,870	1,900	2,600	2,430	[1] 1,340	2,980	106.7
Average	4,011	953	1,697	985	988	1,715	[2] 58.9

[1] 1921 seeding a failure; reseeded in 1922.

[2] 4-year average.

With the four small-grain crops, winter wheat, spring wheat, oats, and barley, the differences in average yields when considered in pounds per acre are small. The greatest average yield was produced by barley. In the six years barley was exceeded by each of the other crops three times. Winter wheat slightly outyielded oats. Spring wheat yielded the least of these four crops, but only 120 pounds per acre less than winter wheat. Winter wheat did not winterkill to any extent in any year, but owing largely to the dry autumns in 1921 and 1922 emerged with a poor stand in two years.

The yield of corn is of special interest. With the shelling percentage of corn calculated at 80 per cent of the total ear weight, the grain

yield of this crop averaged within 27 pounds per acre of that of spring wheat and only 89 pounds less than that of oats. In 1923 the yield of corn was greater than that of any of the small grains. In addition to the grain, the stover yield of corn is of considerably greater value than the straw yield of the small grains.

Sorgo as a forage crop produced good yields in all years except 1919. The average yield for the 6-year period was 2 tons of field-cured forage per acre. Sorgo was grown in cultivated rows only.

Alfalfa and brome-grass have been rather uncertain crops. No yields have been secured in the years of seeding. Second-year alfalfa produced a fair crop in three of the six years and the third-year alfalfa in four of the six years. More than one cutting in a season was obtained in only one year, 1922, when two cuttings were made.

Second-year brome-grass produced a fair crop in only two years, 1918 and 1923. Failure in 1920 was due to no stand being obtained in 1919. Third-year brome-grass produced a yield in three out of the six years, but the yield in 1923 was from a reseeding in 1922 as a consequence of the failure to obtain a stand in 1921.

RESULTS OF FALL AND SPRING PLOWING

In the experiments with crop rotations and tillage methods a number of comparisons between fall plowing and spring plowing are possible where the preparation of the land is the same except for the time of plowing. All of the fall plowing is done as soon as practicable after the crop is removed. In some years corn ground is plowed later than land in small grains because the crop is removed later. For small-grain stubble the date has varied from August 24 to October 6 and for corn ground from September 3 to October 11. Spring plowing for small grains and flax is done as early in the spring as the ground can be worked, and for corn it is done shortly before planting time.

The average annual yields and the average yields for the 6-year period of spring wheat, oats, flax, corn, and barley on comparable fall-plowed and spring-plowed plats are shown in Table 5. Spring wheat on land in small grain the previous year shows a slight but consistent advantage in favor of fall plowing. The higher yield was on spring plowing in 1921 only, but the crop that year was practically a failure on both fall plowing and spring plowing. The average yields for the 6-year period are 15.2 bushels per acre on fall plowing and 1.4 bushels less on spring plowing. On corn ground the difference is even smaller, but the slight advantage is with spring plowing.

With oats following small grains the average yields for fall and spring plowing are the same, 32.4 bushels per acre. There was a slight advantage with fall plowing in three years, and in one year both methods were complete failures.

Only two plats of barley are available for comparison. Both are seeded continuously to that crop. The highest yield was on fall plowing three years and on spring plowing two years. The average yield for the 6-year period is in favor of fall plowing by 2.5 bushels per acre. This is very nearly the same as the results obtained from the pairs of plats treated in a similar manner for spring wheat and for oats.

TABLE 5.—*Annual and average yields of spring wheat, oats, barley, flax, and corn on fall plowing and on spring plowing and of winter wheat on early and on late fall plowing at the Sheridan Field Station for the six years from 1918 to 1923, inclusive*

Crop	Preceding crop	Treatment	Unit of measure	Yields per acre						
				1918	1919	1920	1921	1922	1923	Average
Spring wheat	Small grain	Spring plowed	Bushels	22.3	0	19.2	0.5	25.4	15.1	13.8
Do	do	Fall plowed	do	23.2	0	22.1	0	26.9	19.0	15.2
Do	Corn	Spring plowed	do	28.3	0	24.5	4.0	29.5	19.3	17.6
Do	do	Fall plowed	do	26.5	0	24.2	4.0	29.3	20.5	17.4
Oats	Small grain	Spring plowed	do	53.6	0	50.1	4.3	44.4	41.9	32.4
Do	do	Fall plowed	do	54.7	0	51.5	1.0	44.3	42.9	32.4
Corn:										
Grain	Corn	Spring plowed	do	32.3	0	18.8	0	23.6	42.4	19.5
Stover	do	do	Pounds	2,460	100	1,590	1,650	2,100	2,150	1,675
Grain	do	Fall plowed	Bushels	32.4	0	19.2	0	24.6	49.9	21.0
Stover	do	do	Pounds	2,410	0	1,460	1,350	2,030	2,850	1,683
Grain	Small grain	Spring plowed	Bushels	30.4	0	16.3	0	22.1	37.5	17.7
Stover	do	do	Pounds	2,740	277	1,627	1,383	1,707	2,203	1,656
Grain	do	Fall plowed	Bushels	29.5	0	17.1	0	20.7	34.2	16.9
Stover	do	do	Pounds	2,827	0	1,513	867	1,617	2,007	1,472
Barley	Barley	Spring plowed	Bushels	28.6	0	31.3	2.5	29.2	19.8	18.6
Do	do	Fall plowed	do	26.4	0	39.4	0	36.9	23.8	21.1
Flax	Flax	Spring plowed	do	12.3	0	7.1	0	11.1	2.9	5.6
Do	do	Fall plowed	do	12.5	0	6.1	0	7.5	3.8	5.0
Do	Corn	Spring plowed	do	18.0	0	9.1	0	10.0	9.8	7.8
Do	do	Fall plowed	do	16.0	0	8.6	0	12.1	10.5	7.9
Do	Small grain	Spring plowed	do	11.7	0	7.9	.6	11.8	9.4	6.9
Winter wheat	Winter wheat	Late fall plowed.	do	34.5	0	21.3	3.0	24.3	7.2	15.1
Do	do	Early fall plowed.	do	33.8	0	20.5	2.3	21.2	7.3	14.2

Very little difference is evident in the average yields of flax on fall-plowed and on spring-plowed land, each method yielding better than the other in just half the years in which a crop was produced. It has been generally held that fairly early seeding, not much later than for wheat, is most likely to insure a crop. Early seeding was the practice at this station until 1923. Control of weeds, however, has been a difficult problem. Results of recent experiments at other stations and with the 1923 crop at this station tend to indicate that better results may be had by preparing the land as early as practicable but delaying seeding until late in May or perhaps even the first of June, working the land meantime to kill the weeds as they appear.

Corn following corn shows a slight advantage for fall plowing, but in five out of the six years there was a better growth of stover on the spring plowing. Following wheat and oats and with a larger number of plats than following corn, spring plowing made the highest yield of grain in three of the four years that a crop was produced. The average for the 6-year period, however, was only 0.8 bushel of grain and 184 pounds of stover more on spring plowing than on fall plowing.

Considered as a whole, no significant differences have appeared in the results between fall plowing and spring plowing. Nearly all the differences shown are within the limits of experimental error, being so small that the results of a single year might change the averages for the entire period.

There was considerable variation in the time of plowing in the fall. It is not possible, however, to identify any relations between the time of fall plowing and the yield as compared with that on spring plowing.

Both fall plowing and spring plowing are seeded at the same time. Seeding is done comparatively early in the season. With a large acreage to be handled, plowing in the spring necessarily delays seeding. It has been proved beyond any doubt, and it is generally recognized, that delay in seeding in this section decreases yields. Fall plowing, therefore, is advantageous to the extent that it allows the seeding of small grains to be done during the most suitable time in the spring.

RESULTS OF EARLY AND LATE FALL PLOWING FOR WINTER WHEAT

A comparison of the time of plowing for winter wheat is available from one pair of plats in the continuous-cropping series. One plat is plowed as soon as practicable after the grain is harvested and the other shortly before seeding. The time between harvest and the seeding of winter wheat in this section is very short, and consequently the difference in time of plowing is relatively small. The yields from the two methods for the six years from 1918 to 1923, inclusive, are shown in Table 5. The results show no advantage for the early plowing, the slight difference that appears being in favor of the later plowing.

RESULTS WITH WHEAT AND OATS ON DISKED CORN GROUND AND PLOWED CORN GROUND

With both spring wheat and oats a number of rotations afford comparisons between disking and plowing corn ground as a preparation for the succeeding small-grain crop. All comparisons are between rotations similar in all respects except for the preparation of the ground. The results are shown in Table 6. It may be noted that with both wheat and oats plowing slightly outyielded disking in all years when a crop was made by either method except in 1923. The differences for the most part were small, however, and the average difference in favor of plowing was only 0.8 bushel with each crop for the 6-year period. Considering the fact that disking is much the cheaper and quicker preparation, it seems that seeding corn ground to small grains without plowing must be considered the better practice.

TABLE 6.—*Annual and average yields of spring wheat and oats on disked and on plowed corn ground at the Sheridan Field Station for the six years from 1918 to 1923, inclusive*

Crop	Treatment	Number of plats	Yields per acre (bushels)						
			1918	1919	1920	1921	1922	1923	Average
Spring wheat	Disked	2	23.5	0	24.3	2.1	29.2	21.3	16.7
Do	Plowed	2	27.4	0	24.4	4.0	29.4	19.9	17.5
Oats	Disked	1	56.7	0	50.0	6.6	43.4	52.2	34.8
Do	Plowed	1	59.5	0	52.8	11.9	44.1	45.0	35.6

CORN GROUND COMPARED WITH SMALL-GRAIN STUBBLE FOR WHEAT, OATS, AND BARLEY

Six 3-year rotations of wheat, oats, and corn are available for comparisons of the yields of wheat and of oats following corn and following small grains. In four of them wheat follows corn and oats follows wheat, and in the other two rotations the order is reversed. With

oats, comparison is possible with two more rotations in which barley takes the place of wheat, in one case the oats following the corn and in the other following the barley. The yields of wheat, oats, and barley on corn ground and following small grains are shown in Table 7.

TABLE 7.—*Annual and average yields of spring wheat, oats, and barley on corn ground and following small grains at the Sheridan Field Station for the six years from 1918 to 1923, inclusive*

Crop	Preceding crop	Yields per acre (bushels)						
		1918	1919	1920	1921	1922	1923	Average
Spring wheat	Corn	25.4	0	24.3	3.1	29.3	20.6	17.1
Do	Small grains	23.4	0	23.0	0	28.6	19.6	15.8
Oats	Corn	59.1	0	51.7	7.7	45.7	48.5	35.5
Do	Small grains	55.8	0	51.3	2.7	47.9	44.1	33.6
Barley	Corn	42.3	0	44.0	3.8	55.2	36.3	30.3
Do	Small grains	40.5	0	43.3	3.8	59.6	25.8	28.8

With wheat there is a small but consistent gain in yield where the crop follows corn. The average gain for the 6-year period is 1.3 bushels per acre, with a yield of 17.1 bushels on corn ground. With oats the yield following corn was best in four of the five years in which a crop was produced. The average difference in favor of corn ground for oats was 1.9 bushels per acre, with a yield of 35.5 bushels per acre on corn ground.

With barley two plats are available for comparison, one with barley on disked corn ground and the other with the barley on spring plowing following oats. In three of the five years in which a crop was produced the yield was in favor of the corn ground. In 1921 the yield was very low, but the same by both methods. For the 6-year period the average yield was 30.3 bushels per acre on corn ground and 28.8 bushels following oats.

RESULTS ON FALLOW AND FOLLOWING SMALL GRAINS

The experiments offer a number of comparisons for study of the relative yields of various crops on fallow and on land in crop the previous year. In the continuous-cropping series two plats, C and D, are alternately cropped and fallowed, plat C being in crop in the even years and plat D in the odd years. Plats A and B are continuously seeded to the same crop, and for spring-seeded crops plat A is shallow spring plowed and plat B deep fall plowed. With winter wheat plat B is plowed as soon after harvest as possible and plat A shortly before seeding.

Other opportunities for comparison are afforded by several rotations, in some of which the crop under consideration is on fallow and in others it follows a small-grain crop. The yields of the several crops on fallow and following small grains are shown in Table 8.

In the best crop years there were instances where the yield following another grain crop was greater than on fallow, but, in general, the yields on fallow have been considerably more. With winter wheat the yields on the plat alternately fallowed averaged 23.5 bushels per acre for the 6-year period as compared with 15.2 bushels on the late-

plowed plat and 14.2 bushels on the early-plowed one, showing increases of 8.3 and 9.3 bushels in favor of fallow. In the rotations with which comparisons may be made, the average yield on fallow was 27.7 bushels per acre, as compared with 16.8 bushels following a grain crop, an increase of 10.9 bushels for the fallow.

With spring wheat the average yield on the alternate fallow was 20.3 bushels. This is 7.8 bushels more than the yield from spring plowing continuously cropped and 6.4 bushels more than from fall plowing. In rotations the yield following fallow averaged 23 bushels per acre, or 7.7 bushels more than following small grain.

TABLE 8.—*Yields of winter wheat, spring wheat, oats, and barley following small grains and fallow at the Sheridan Field Station for the six years from 1918 to 1923, inclusive*

Crop	Preceding crop	Treatment	Yields per acre (bushels)						
			1918	1919	1920	1921	1922	1923	Average
Winter wheat	Winter wheat	Late plowed	35.4	0	21.3	3.0	24.3	7.2	15.2
Do	do	Early plowed	33.8	0	20.5	2.3	21.2	7.3	14.2
Do	Fallow	Alternate fallow	44.2	9.9	30.0	14.0	20.8	22.3	23.5
Do	do	Fallow in rotation	38.0	7.2	32.0	23.8	38.8	26.5	27.7
Do	Small grains		32.6	0	25.4	2.7	29.6	10.4	16.8
Spring wheat	Spring wheat	Spring plowed	21.1	0	16.2	1.0	22.7	13.7	12.5
Do	do	Fall plowed	23.1	0	20.5	0	24.5	15.2	13.9
Do	Fallow	Alternate fallow	29.2	3.3	23.3	7.0	34.2	24.8	20.3
Do	do	Fallow in rotation	30.3	5.0	23.7	20.5	34.0	24.2	23.0
Do	Small grains		21.6	0	24.3	1.5	29.5	14.8	15.3
Oats	Oats	Spring plowed	50.6	0	48.8	3.4	38.4	38.8	30.0
Do	do	Fall plowed	53.1	0	51.9	0	42.5	44.4	32.0
Do	Fallow	Alternate fallow	61.2	2.2	55.3	14.7	50.6	65.6	41.6
Do	do	Fallow in rotation	58.9	2.8	58.4	25.3	39.1	66.3	41.8
Do	Wheat	Wheat on fallow	57.2	0	60.3	3.1	61.6	48.1	38.4
Do	Small grains		55.8	0	51.3	2.7	47.9	44.1	33.6
Barley	Barley	Spring plowed	28.6	0	31.3	2.5	29.2	19.8	18.6
Do	do	Fall plowed	26.4	0	39.4	0	36.9	23.8	21.1
Do	Fallow	Alternate fallow	47.9	4.2	42.9	13.5	36.9	34.4	30.0

Oats have shown about the same increase in yields on fallow as spring wheat. In the continuous-cropping series the average yield on fallow was 41.6 bushels per acre, an increase of 11.6 bushels over spring plowing and 9.6 bushels over fall plowing. In rotations that were comparable the increased yield due to fallow was slightly less. The yield on fallow was about the same, but the production following small grains was slightly higher than in the continuous-cropping series. The increased yield of oats on fall plowing after wheat on fallow over the yield following small grains in other rotations is of interest in this connection. This increase amounted to nearly 5 bushels per acre, apparently owing to a carry-over effect from the fallow preceding the wheat crop. Where the rotation was reversed, with oats on fallow and wheat following oats, no such effect was noticeable. This condition is in line with the results obtained at other stations having similar tests.

With barley the only comparison possible is with alternate fallow and continuous cropping. The average yields for the 6-year period were 18.6 bushels on spring plowing, 21.1 bushels on fall plowing, and 30 bushels on fallow, an increase of about half on fallow.

RESULTS ON FALLOW AND ON CORN GROUND

The average yield of winter wheat in rotations where fallow may be compared with corn ground was 31.1 bushels on fallow and 20.5

bushels on corn ground, an increase on fallow of half the yield on corn ground. The yield on fallow was the higher every year and was 11.2 bushels in 1919, when drought was so severe that winter wheat grown by every other method failed completely. Table 9 shows the yields each year and the averages for the entire period.

TABLE 9.—*Annual and average yields of winter wheat, spring wheat, oats, barley, and corn on fallow and on corn ground at the Sheridan Field Station for the six years from 1918 to 1923, inclusive*

Crop	Preparation	Unit of measure	Yields per acre						
			1918	1919	1920	1921	1922	1923	Average
Winter wheat	Fallow	Bushels	47.7	11.2	34.0	24.8	33.0	35.8	31.1
Do	Corn ground	do	36.0	0	32.0	10.2	25.3	19.6	20.5
Spring wheat	Fallow	do	30.3	5.0	23.7	20.5	34.0	24.2	23.0
Do	Corn ground	do	26.5	0	24.2	4.0	29.3	20.5	17.4
Oats	Fallow	do	58.9	2.8	58.4	25.3	39.1	66.3	41.8
Do	Corn ground	do	59.1	0	51.7	7.7	45.7	48.5	35.5
Barley	Fallow	do	47.9	4.2	42.9	13.5	36.9	34.4	30.0
Do	Corn ground	do	42.3	0	44.0	3.8	55.2	36.3	30.3
Corn:									
Grain	Fallow	do	28.1	0	19.9	15.4	23.4	42.3	21.5
Stover	do	Pounds	2,370	630	1,710	1,600	1,760	1,600	1,612
Grain	Corn ground, spring plowed.	Bushels	32.3	0	18.8	0	23.6	42.4	19.5
Stover	do	Pounds	2,460	100	1,590	1,650	2,100	2,150	1,675
Grain	Corn ground, fall plowed.	Bushels	32.4	0	19.2	0	24.6	49.9	21.0
Stover	do	Pounds	2,410	0	1,460	1,350	2,030	2,850	1,683

With spring wheat and oats the increases in yield by fallow over corn ground are considerably less. In the comparable rotations the average yield of spring wheat on fallow was 23 bushels and on corn ground 17.4 bushels, an increase of only 5.6 bushels due to fallow. The yield of oats on fallow was 41.8 bushels and on corn ground 35.5 bushels. Corn ground outyielded fallow one year with spring wheat and two years with oats. In the dry year of 1921 fallow outyielded corn ground with both crops by a considerable margin, and in 1919 small yields were produced on fallow and none on corn ground.

From these data it appears that winter wheat may be depended upon to produce fair yields on fallow even in the dry years when the crop is more or less completely a failure with other methods of soil preparation. The average yield for the 6-year period is about 50 per cent more on fallow than after either small grain or corn. With spring grain, however, the increase in yield by fallow over the other methods is not so great. Fallow undoubtedly may be depended upon for light yields when other methods may result in failures. On the average, however, the increase in yield by this method is not sufficient to warrant the practice of seeding more than a small part of the spring grain on fallow in preference to the other tillage preparations, especially that of corn ground.

With corn, comparisons are afforded between alternate fallow and continuous cropping by different methods. The yield of grain averaged 2 bushels per acre more on fallow than on spring plowing continuously cropped to corn and half a bushel more than on fall plowing. The yield of stover was slightly less on fallow than on either

the spring or the fall plowing. These results show that fallow is of little actual benefit to corn.

RESULTS FROM BARNYARD MANURE IN ROTATIONS

A number of rotations to determine the effect of the application of barnyard manure are included in the investigations at the Sheridan Field Station. All but one of these include corn, oats, and wheat in varying combinations, two include fallow, and one is alternate corn and flax. In three rotations the manure is applied just previous to the corn crop, in one just previous to the oats, in one previous to the wheat crop, and in two rotations it is applied just before plowing for fallow, which is followed in one rotation by wheat and in the other by oats.

During the period covered by this report each plat in the 2-year rotations was manured three times and in the 3-year rotations twice. All plats in the 4-year rotations were manured once and part of them twice. The first crop following the manure in the 4-year rotations in 1922 and 1923 was on land manured the second time.

With wheat no effect from the manure can be discerned when compared with the crop grown under conditions otherwise similar but without the application of manure. Oats apparently show a slightly increased yield on manured fallow and when the manure is applied directly before the oat crop. The yield of stover appears to be slightly increased when the manure is applied directly to the corn crop, but no difference has been shown in the grain yield. No effect beyond the year the manure is applied can be observed with any crop. It should be borne in mind that these experiments were begun on new land and that the results from the use of manure may not be evident as soon as on land that has been cropped for a number of years.

RESULTS WITH GREEN MANURE COMPARED WITH THOSE ON FALLOW

To determine the effect on yields and on the humus content of the soil, experiments were instituted in which winter rye, field peas, and sweet clover are grown and plowed under for green manures.

At Sheridan this group of experiments is confined to 4-year rotations in which a green-manure crop is plowed under on each plat every four years. The crops in the other three years are wheat, corn, and oats. In one set of rotations wheat follows the green manure and oats follow corn, and in another set the order is reversed. With rye and field peas both winter-wheat and spring-wheat rotations are included, but with sweet clover only the winter-wheat rotations are used. For comparison with the green-manure rotations there are similar rotations containing bare fallow. The green manure is fairly comparable with the fallow, in that each of them involves the loss of the use of the land for one year. The green-manure plat after plowing is treated the same as fallow for the remainder of the season. The green manure is essentially a modified fallow, requiring the extra expense of seed and seeding.

No effect on yield, other than the effect of the partial fallow, that can be attributed to the green manure can be noted with any crop, whether immediately following the green manure or later in the rotation. Yields generally are no greater than on bare fallow. Spring

wheat showed a slightly larger yield following green manure in 1923, but only by a longer trial can it be determined whether this effect was due to the green manure. With the heavily increased cost of the green manure its use is not justified.

RESULTS OF PLOWING FALLOW AT DIFFERENT TIMES

Included in the work with fallow is an experiment designed to determine what difference, if any, may be expected from plowing for fallow at different dates. For this purpose four pairs of plats are used, designated as H and I, J and K, L and M, and N and O, respectively. One plat of each pair is in spring wheat each year and the other is fallowed. When plats I, K, M, and O are in crop, plats H, J, L, and N are in fallow. The fallow plat in the pair H and I is plowed for fallow as soon as practicable after the grain crop is removed in the fall. It is worked shortly afterward with the disk set nearly straight or with the spring-tooth harrow and is cultivated sufficiently the following summer to keep it free from weeds. The fallow plat in the pair J and K is plowed at the same time but is not worked down, being left rough over winter. It is given the same cultivation during the next summer as the H or I plat. The fallow plat in the pair L and M is left in stubble over winter and is plowed in the spring at about the time of plowing for corn. From that time it is given the same cultivation as the fall-plowed fallows. The fallow plat in the pair N and O is plowed about a month later and given the minimum cultivation necessary to keep the land free from weeds. The yields for each year and the averages for the 6-year period are shown in Table 10.

TABLE 10.—*Annual and average yields of spring wheat with different methods of fallow at the Sheridan Field Station for the 6-year period from 1918 to 1923, inclusive*

Plats	Treatment	Yields per acre (bushels)						
		1918	1919	1920	1921	1922	1923	Average
H and I	Fall plowed; cultivated immediately	24.5	4.3	19.5	25.2	26.3	29.7	21.6
J and K	Fall plowed; rough first winter	23.4	6.6	20.7	25.2	26.8	32.7	22.6
L and M	Spring plowed at time of plowing for corn.	25.2	7.1	23.3	23.7	32.2	32.8	24.1
N and O	Summer plowed; late June or early July.	23.9	4.0	22.0	20.7	29.8	30.2	21.8

It will be noted that the highest yield was on the fallow plowed early in the spring. The average yield by this method was 24.1 bushels per acre. Plowing in the fall yielded best in only one year, the average yields of the fall-plowed fallows being 2.5 and 1.5 bushels per acre, respectively, less than the yield of the fallow plowed early in the spring. A decrease in yield for the late plowing is noted in every year, the average being 2.3 bushels below that of the earlier plowing. Of the two plats plowed in the fall, the one left rough over winter averaged 1 bushel per acre more than the plat worked in the fall after plowing.

RESULTS OF SUBSOILING AND OF LISTING

One plat which is subsoiled and one which is listed are included in the continuous-cropping series of each of six crops. The subsoiled plat is fall plowed each year. For two years in succession it is sub-

soiled when plowed to a depth of from 6 to 8 inches below the plowing and then is plowed without subsoiling for two years. Aside from the subsoiling this plat is treated the same as plat B, the other fall-plowed plat in this series. A plat is listed in the fall for each of the small grains and worked down level shortly before seeding. For corn the listing is done at the time of planting, a lister planter being used.

For winter wheat, spring wheat, and flax the fall plowing without subsoiling showed higher average yields for the 6-year period than the subsoiling, although there were instances in some years when the subsoiling yielded most. For winter wheat the average yields were 14.2 and 13.5 bushels per acre, respectively, for the ordinary fall plowing and the subsoiling, for spring wheat 13.9 and 13.1 bushels, and for flax 5 and 4 bushels.

With oats the difference in the average yields of the two plats was only 0.3 of a bushel. Barley on the subsoiled plat showed a slightly increased yield each year that a crop was produced, but it averaged only 3.5 bushels more than on the plat not subsoiled, the average yields for the six years being 24.6 and 21.1 bushels, respectively. This increase is not enough to pay for the extra work of subsoiling. Corn averaged 0.4 bushel more of grain and 150 pounds less of stover on the subsoiled plat than on the one not subsoiled.

Every crop except barley yielded less on listing than on ordinary fall plowing. The difference in yield ranged from 0.4 bushel per acre with flax to 7.8 bushels of grain and 510 pounds of stover with the corn crop. Barley yielded 0.8 bushel more by the listing. The extra work required to put the listing in condition for seeding to small grains amounts to fully as much as the saving in the first tillage operation, and consequently listing for small grains can not be recommended.

RESULTS WITH SOD CROPS

Two rotations containing sod crops, one with alfalfa and one with brome-grass, are included in the experiments. Both are 6-year rotations in which the brome-grass and the alfalfa occupy the land for three years, including the year of seeding. The sod is plowed up after the crop is taken off in the third year and is followed by oats, corn, and wheat in succession. No crop is secured the year of seeding the brome-grass or alfalfa. The yields of brome-grass and alfalfa were included in the general report on crop yields summarized earlier. Yields of the other crops in these rotations do not vary noticeably from those obtained under similar conditions in other rotations.

EFFECT OF SORGO ON SUCCEEDING GRAIN CROPS

Sorgo (sweet sorghum) is grown in two rotations in which the yields following this crop may be compared with those following corn or other crops in other rotations. The average yield of sorgo was shown in Table 4, accompanying the discussion of average yields. Rotation 48 is sorgo, wheat, and oats, all on spring plowing. The average yield of wheat following sorgo for the 6-year period was 13.9 bushels. This is 3.2 bushels less than the yield following corn and 1.1 bushels less than that following other small grains in the rotations. The yield following sorgo was slightly less than that following corn each year and was lower than that following other small grains in three of the five years in which a crop was produced. The average

yield of oats following wheat in the sorgo rotation was 31.6 bushels, as compared with 33.6 bushels following small grains in other rotations, a difference of 2 bushels per acre.

Results are available for only the last three years for the other rotation in which oats follow sorgo. During this time the average yield was 35 bushels per acre, as compared with 34.1 bushels following corn in rotation 4. The yield following sorgo was highest in two of the three years. In this rotation wheat follows the oats, and its yield was about the same as that following oats in other rotations.

It appears then that with wheat there may be a slightly depressing effect from the sorgo on the succeeding crop. With the short record available for oats following sorgo this effect does not appear.

VARIETAL EXPERIMENTS

Experiments are conducted to determine the varieties of field crops best adapted to this section and to learn the best time and rate of seeding. The work was outlined and the original seed supplied by the Office of Cereal Investigations, Bureau of Plant Industry, United States Department of Agriculture. That office also contributed to the expense of the work from 1917 to 1920, inclusive. Varietal trials are conducted with winter wheat, spring wheat, oats, barley, and corn. Flax was included from 1917 to 1920, but was discontinued after that time. The number of varieties of each crop necessarily has been limited, and generally only those have been included that were considered best adapted to this section, were already being grown here, or were representative of types thought to be adapted.

Previous to 1921 the varietal experiments were conducted on plats one-twentieth of an acre in size, while the experiments with rates and dates of seeding were on fortieth-acre plats. Beginning with 1921 all experiments were conducted on the smaller plats. Throughout the entire period each variety was grown on three systematically replicated plats in order to guard against differences due to soil variation.

TABLE 11.—*Annual and average yields of winter-wheat varieties at the Sheridan Field Station for the seven years from 1917 to 1923, inclusive*

Variety	C. I. No.[1]	Yields per acre (bushels)								
		1917	1918	1919	1920	1921	1922	1923	Average 1917 to 1923	Average 1918 to 1923
Kharkof	1442	9.3	44.4	17.2	38.4	22.1	28.5	20.9	25.8	28.6
Turkey	1571	9.2	42.8	11.4	34.7	18.2	29.1	23.3	24.1	26.6
Kanred	5146	-----	43.3	11.9	32.0	22.1	26.0	16.7	-----	25.3
Crimean	1559	8.1	44.5	13.9	36.3	21.9	27.8	23.8	25.2	28.0
Alton	1438	6.6	44.1	9.6	33.3	15.3	30.5	21.6	23.0	25.7
Beloglina	1543	7.5	42.4	8.9	32.0	18.0	26.0	21.8	22.4	24.9
Buffum No. 17	3330	6.1	42.2	10.3	30.9	11.9	14.7	4.0	17.2	19.0

[1] Cereal Investigations serial number.

WINTER WHEAT

Seven varieties of winter wheat were grown. Table 11 shows the annual yield of each variety and the averages for the two periods from 1917 to 1923 and from 1918 to 1923, inclusive. Kanred was not

grown in 1917; consequently the average from 1918 to 1923 is included to allow comparisons of this variety with the others. Of the three best-known varieties grown commercially, Kharkof outyielded Turkey in every year except the last two and averaged 25.8 bushels for the 7-year period, as compared with 24.1 bushels for Turkey. The lower yield of Kharkof in 1923 was due partly to washing caused by run-off from melting snow in the spring. Kharkof outyielded Kanred every year except 1921, when the yields of both varieties were the same. Crimean, which is a similar strain of Turkey, has yielded well but slightly less than Kharkof.

SPRING WHEAT

Of the spring-wheat varieties 20 have been grown at Sheridan. Some of the varieties originally grown were discontinued after 1920, and others were added in 1921. Consequently, average yields for three periods are shown in Table 12 for these varieties as follows: From 1917 to 1920, from 1917 to 1923, and from 1921 to 1923. From 1917 to 1922, inclusive, the varietal experiments with spring grains were on cornland, and in 1923 they were on fallow.

TABLE 12.—*Annual and average yields of spring-wheat varieties at the Sheridan Field Station for the seven years from 1917 to 1923, inclusive*

Class and variety	C. I. No.	Yields per acre (bushels)									
		1917	1918	1919	1920	1921	1922	1923	Average		
									1917 to 1920	1917 to 1923	1921 to 1923
Common:											
Marquis	3641	6.8	31.1	0	20.6	1.9	30.9	25.3	14.6	16.7	19.4
Power	3697	10.0	30.3	0	25.0	2.2	27.8	25.6	16.3	17.3	18.5
Ghirka	1517	9.3	29.6	0	25.4				16.1		
Glyndon	2873	7.2	26.1	0	23.7				14.3		
Ruby	6047					2.2	28.0	28.5			19.6
Red Bobs	6255					3.6	29.3	28.9			20.6
Hard Federation	4733					3.0	27.8	33.8			21.5
Haynes Bluestem	2874	7.0	27.5	0	21.0	1.2	20.4	22.0	13.9	14.2	14.5
Kota	6248					3.2	33.3	27.3			21.3
Preston	3081	9.3	23.6	0	23.3	2.7	29.1	24.1	14.1	16.0	18.6
Pioneer	4324	10.8	29.7	0	19.2	2.8	33.8	22.4	14.9	17.0	19.7
Prelude	4323	12.2	22.6	0	16.1				12.8		
Durum:											
Kubanka	1440	8.7	27.5	0	25.0	2.3	28.2	26.7	15.3	16.9	19.1
Kubanka No. 8	4063	8.8	25.1	0	21.2				13.8		
Arnautka	4064	10.0	20.4	0	26.2	2.0	32.7	26.4	14.2	16.8	20.4
Monad	3320					2.6	29.3	27.3			19.7
Acme	5284					2.4	28.4	27.8			19.5
Peliss	1584	12.7	26.6	0	17.3	2.8	28.9	31.1	14.2	17.1	20.9
Beardless								25.8			
Nodak	6519							26.2			

In general, the differences in yield between varieties of spring wheat were small and not consistent from year to year. The highest yielding variety for the entire 7-year period was Power, a Fife wheat commonly grown a few years ago, which averaged 17.3 bushels. The yield of Marquis for the same period, however, was only 0.6 of a bushel less. The durum varieties outyielded Marquis but by a smaller margin than Power. Kota, under trial for three years, outyielded Marquis on the average by 1.9 bushels per acre. At other

stations where stem rust has occurred Kota has proved very resistant to that disease. Stem rust has not developed on spring wheat at this station. Hard Federation, a short early-maturing variety, outyielded Kota in 1923 by 6.5 bushels, but averaged only 0.2 bushel more for the 3-year period in which both varieties were under trial.

OATS

Annual and average yields of the oat varieties grown for one or more years of the 7-year period from 1917 to 1923, are shown in Table 13. The early Sixty-Day variety produced the best yields in the dry years 1917 and 1921. Apparently, owing to maturing earlier in 1923 and thereby escaping to a large extent the heat and dry weather of that year, the Sixty-Day outyielded the Victory, the best midseason variety, by nearly 30 bushels. In the other years except 1917 and 1921 the midseason varieties produced the highest yields. For the 7-year period the Sixty-Day averaged 33.8 bushels per acre, as compared with 32.3 bushels for Golden Rain, the highest yielding midseason variety. White Tartar, a late side variety, averaged the least of the six varieties grown for the seven years.

TABLE 13.—*Annual and average yields of oat varieties at the Sheridan Field Station for the seven years from 1917 to 1923, inclusive*

Group and variety	C. I. No.	Yields per acre (bushels)							Average	
		1917	1918	1919	1920	1921	1922	1923	1917 to 1923	1921 to 1923
Early:										
Sixty-Day	165	20.4	46.2	0	39.8	7.1	39.2	83.8	33.8	43.4
Albion (Iowa No. 103)	729	21.5	48.2	0	36.3	3.8	32.5	55.0	28.2	30.4
Midseason:										
Swedish Select	134	12.7	55.4	0	42.5	2.7	42.9	46.7	29.0	30.8
Golden Rain	493	11.3	57.1	0	49.8	4.8	54.6	48.4	32.3	35.9
Silvermine	714	19.2	59.4	0	48.1	2.9	42.1	42.5	30.6	29.2
Victory	742	------	------	------	------	2.7	41.3	54.2	----------	32.7
Early Mountain No. 8	2036	------	------	------	------	------	------	54.2	----------	----------
Late (side):										
White Tartar (White Russian)	732	13.1	53.5	0	40.4	2.7	30.4	25.0	23.6	19.4

BARLEY

Table 14 shows the yields of barley varieties each year, together with the average yields for the two periods from 1917 to 1923 and from 1921 to 1923. Trebi, a 6-rowed variety, had the highest average both for the longer and the shorter period. White Smyrna, a 2-rowed variety, outyielded Trebi in three years, 1917, 1920, and 1921, and averaged 22.9 bushels for the 7-year period, only 2.4 bushels less than Trebi. In general, the difference in yield between the better producing varieties was small and varied from year to year. Trebi in addition to averaging better than White Smyrna has a longer straw and is handled more easily.

FLAX

The varietal trial with flax ran only four years. It was discontinued after 1920 because of consistently low yields and the lack of sufficient land suitable for the work. The yields are shown in Table

15. No wilt or other disease appeared to any appreciable extent. Russian thistles usually became quite thick by the end of the season, decreasing the yield and making the crop difficult to handle.

TABLE 14.—*Annual and average yields of barley varieties at the Sheridan Field Station for the seven years from 1917 to 1923, inclusive*

Class and variety	C. I. No.	Yields per acre (bushels)							Average	
		1917	1918	1919	1920	1921	1922	1923	1917 to 1923	1921 to 1923
2-rowed:										
White Smyrna	195	24.7	26.5	0	29.4	3.9	22.9	52.8	22.9	26.5
Hannchen	531	13.4	30.9	0	21.1	2.7	30.2	45.0	20.5	26.0
Svanhals	187	11.8	35.1	0	21.3	4.6	25.8	51.1	21.4	27.2
6-rowed:										
Club Mariout	261	20.8	17.9	0	19.2	2.5	15.5	46.1	17.4	21.4
Coast	690	18.2	26.7	0	24.0	2.1	27.1	57.0	22.2	28.7
Trebi	936	18.3	33.1	0	23.9	2.5	31.3	68.1	25.3	34.0
Manchuria	244	12.1	28.5	0	22.9	1.6	26.2	57.5	21.3	28.4
Nepal	595	10.3	13.0	0	10.4					
Flynn	1311					3.6	18.2	44.7		22.2
Horn	926					3.3	33.8	55.6		30.9

Work with flax is still being conducted in connection with the experiments with crop rotations and tillage methods. As shown in the discussion of that work, fair yields were obtained in 1922 and 1923 when the crop was grown in rotations, and it seems probable that with the proper rotation and tillage methods profitable yields of flax may be secured.

TABLE 15.—*Annual and average yields of flax varieties at the Sheridan Field Station for the four years from 1917 to 1920, inclusive*

Variety	C. I. No.	Yields per acre (bushels)				
		1917	1918	1919	1920	Average
Damont (North Dakota No. 1215)	3	3.8	8.0	0	3.3	3.8
North Dakota Resistant No. 52	8	2.9	8.4	0	5.0	4.1
Primost (Minnesota No. 25)	12	2.1	8.1	0	4.9	3.8
North Dakota Resistant No. 114	13	2.6	7.0	0	4.3	3.5
Reserve (North Dakota No. 155)	19	2.9	8.3	0	4.5	3.9

CORN

A big factor with respect to the adaptability of different varieties of corn is the length of the frost-free period and the time available in the fall for ripening before a killing frost. As was noted earlier in this bulletin, the date of the first killing frost in the fall is quite variable. The conditions at the station probably are fairly typical of the greater part of the section in this respect, but in some seasons there has been considerable difference even within a short distance of the station. Generally when there has been a difference the killing frost has occurred at the station earlier than over much of the immediately surrounding territory.

Table 16 shows the total yield of fodder, including grain, and the yield of grain produced each year by eight varieties of corn, representative of the various types grown. Averages for the two periods

from 1917 to 1923, inclusive, and for 1922 and 1923 are also shown. The yields in some years were reduced by hail, but they were fairly comparable.

TABLE 16.—*Annual and average yields of varieties of corn at the Sheridan Field Station for the seven years from 1917 to 1923, inclusive*

Class and variety	Fodder and grain yields per acre (pounds)								
								Average	
	1917	1918	1919	1920	1921	1922	1923	1917 to 1923	1922 and 1923
Dent:									
Northwestern	2,630	4,500	0	2,980	1,875	1,920	3,215	2,446	2,568
Payne White					2,400	3,000	3,510		3,255
Selection No. 133	4,290	5,540	0	3,520	2,625	2,750	4,315	3,291	3,533
Minnesota No. 13	4,280	4,540	0	3,710	2,325	2,920	3,660	3,062	3,290
Flint:									
Gehu	3,220	3,600	0	3,110	1,500	2,330	4,905	2,666	3,618
Dakota White						3,830	4,700		4,265
Assinniboine						2,080	3,924		3,002
Rainbow						4,670	6,220		5,445
	Grain yields (bushels)								
Dent:									
Northwestern	14.0	29.3	0	13.9	5.2	15.3	28.9	15.2	22.1
Payne White					6.0	21.9	31.2		26.6
Selection No. 133	20.2	32.9	0	0	3.2	[1] 17.8	32.1	15.2	25.0
Minnesota No. 13	19.4	29.9	0	0	3.8	21.0	29.6	14.8	25.3
Flint:									
Gehu	21.2	28.8	0	22.7	5.4	18.9	33.7	18.7	26.3
Dakota White						24.3	31.5		27.9
Assinniboine						14.7	29.4		22.1
Rainbow						21.0	31.9		26.5

[1] Not mature.

Northwestern and Payne White are two of the earliest dent varieties included in the experiments. Both mature at about the same time and matured fully ripe corn every year in which a crop was produced. The Payne White outyielded Northwestern each year.

Selection No. 133 and Minnesota No. 13 are representatives of later and larger growing varieties. At this station these varieties have not averaged larger grain yields than the smaller growing earlier varieties, but they have produced larger total yields of fodder. They matured in only three of the six years in which a crop was produced, and the ears were soft. In 1920 both varieties were frosted while in the milk stage, and in 1922 and 1923 the corn was soft when harvested early enough to prevent a loss of the fodder by drying up. Probably as great a crop of total feed has been produced from the early-maturing varieties as from the later ones.

The early flint varieties, such as Gehu and Dakota White, have produced as large yields of grain as have been secured. These varieties are difficult to harvest with a corn binder but are valuable for hogging off. Assinniboine flint has not yielded quite as well but is several days earlier, being the earliest variety that has been tested.

Several varieties procured locally were planted in 1923. Some of these outyielded the early varieties shown in the table, their maturity

being midway between that of the early dent varieties and that of varieties of the Minnesota No. 13 type, but their value can hardly be determined without further trial.

RATE-OF-SEEDING TESTS

Experiments with rates of seeding have been conducted with winter wheat, spring wheat, oats, and barley. The work with oats and barley was discontinued after 1920.

WINTER WHEAT

Winter wheat was seeded at the rate of 2, 3, 4, 5, 6, and 8 pecks per acre on three different dates, August 15, September 15, and October 15. The 3, 4, and 6 peck rates were seeded also on the first of each of the above-named months and the first of November, making seven seedings each year at these rates. Table 17 shows the average yield for each rate for each year and the average yields for the 6-year period from 1918 to 1923, inclusive.

TABLE 17.—*Annual and average yields of winter wheat, spring wheat, oats, and barley sown at the rates specified for the years shown during the 7-year period from 1917 to 1923, inclusive*

Crop and rate of seeding per acre	Yields per acre (bushels)							
	1917	1918	1919	1920	1921	1922	1923	Average
Winter wheat:								
2 pecks[1]	------	55.4	7.2	36.5	22.3	35.0	23.2	29.9
3 pecks[1]	------	53.2	7.9	37.6	22.2	35.2	25.0	30.2
4 pecks[1]	------	54.8	8.8	40.4	23.1	39.9	27.7	32.5
5 pecks[1]	------	54.3	10.0	42.0	25.3	42.8	31.0	34.2
6 pecks[1]	------	54.7	9.9	43.0	28.8	43.4	33.1	35.5
8 pecks[1]	------	54.0	8.4	44.0	29.1	44.4	34.1	35.7
3 pecks[2]	------	52.8	7.4	36.9	20.3	36.7	22.2	29.4
4 pecks[2]	------	54.0	7.7	39.3	20.9	37.6	23.9	30.6
6 pecks[2]	------	53.8	8.3	42.4	25.4	42.8	28.1	33.5
Spring wheat:								
2 pecks	6.9	17.2	0	11.6	1.9	29.1	22.9	12.8
3 pecks	6.7	17.5	0	13.1	2.4	24.4	23.8	12.6
4 pecks	5.8	19.1	0	15.3	2.7	28.0	22.9	13.4
5 pecks	4.9	19.2	0	16.0	2.9	23.6	24.7	13.0
6 pecks	4.9	17.5	0	16.2	2.6	26.5	22.0	12.8
8 pecks	4.7	16.8	0	18.0	2.6	24.4	20.0	12.4
Oats:								
2 pecks	------	36.1	0	25.0	------	------	------	------
3 pecks	16.3	37.7	0	32.5	------	------	------	21.6
4 pecks	17.9	38.3	0	35.5	------	------	------	22.9
5 pecks	18.8	33.8	0	32.1	------	------	------	21.2
6 pecks	20.0	40.4	0	31.3	------	------	------	22.9
8 pecks	18.8	35.4	0	32.9	------	------	------	21.8
Barley:								
2 pecks	------	25.3	0	20.0	------	------	------	------
3 pecks	10.0	28.8	0	35.0	------	------	------	18.5
4 pecks	13.6	33.2	0	36.9	------	------	------	20.9
5 pecks	13.3	30.5	0	34.7	------	------	------	19.6
6 pecks	12.5	32.9	0	40.8	------	------	------	21.6
8 pecks	7.0	31.1	0	41.1	------	------	------	19.8

[1] Average of three dates of seeding. [2] Average of seven dates of seeding.

It will be noted that in general the yield increased directly with the increased quantity of seed used from the 2-peck rate to the 8-peck rate. The difference in average yield with the two highest rates of seeding, 6 and 8 pecks, is very small, amounting to less than half the difference in the quantity of seed used. Between the 4-peck and 6-peck rates of seeding the average difference in yield for the seven

seedings each year is 2.9 bushels per acre, with a total average yield of 30.6 bushels for the 4-peck rate.

These variations in yield have not been fully consistent, however, either from year to year or between seedings at different dates for the same year. The average of the October 1 seeding for the 6-year period shows a difference of 1.3 bushels per acre in favor of the 6-peck rate over the 4-peck rate, whereas with the October 15 seeding there is a difference of 0.1 of a bushel in favor of the 4-peck rate. Between the 3-peck and the 4-peck rates the average difference for the seven seedings each year was 1.2 bushels per acre in favor of the 4-peck rate. The variation was fairly consistent throughout the test.

This trial was conducted on fallow throughout the entire period of the experiment, but the theory that the results might be reversed with less favorable tillage methods does not find much support. The results in years of light rainfall showed practically the same type of variation between the 3, 4, and 6 peck rates of seeding as was shown in the years with better moisture conditions.

With the thicker seedings, above the 4-peck rate, the stand usually was considerably thicker, the straw yield heavier, and sometimes the quality of the grain poorer. Consequently, it appears that the 4-peck rate of seeding has given the most profitable yields.

SPRING WHEAT, OATS, AND BARLEY

Rate-of-seeding tests with spring grains were conducted with only a single date of seeding. Results with these crops for each year and the averages for the periods in which the experiments were conducted are shown in Table 17. These crops were grown on corn ground except in 1923, when they were on fallow. Consequently, the yields of these crops have averaged considerably smaller than those of winter wheat in proportion to the average yields secured in rotations. The 4-peck rate averaged highest with wheat. Both lighter and heavier seedings yielded slightly more in some years, and the 2-peck rate averaged within 0.6 bushel of the 4-peck rate. The 4-peck seeding produced sufficiently higher yields to warrant seeding at the heavier rate in only two years, 1918 and 1920, and in other years there was but little difference. With oats and barley for the time the tests were run, seeding at 4 pecks per acre seemed to show the most profitable yields.

DATE-OF-SEEDING TESTS

Date-of-seeding trials with winter wheat, spring wheat, oats, and barley were conducted the same as those to determine the best rates of seeding. Results with these trials, however, are more conclusive. The yields for the different dates for each year and for the period the experiments were conducted with each crop are shown in Table 18.

The October 1 seeding of winter wheat yielded highest in three of the six years. The 6-year average yield was 35.7 bushels per acre, as compared with 34.2 bushels for the seeding of September 15. Yields from seedings either earlier or later than these dates averaged more than 2 bushels less, and seeding either earlier than August 15 or later than October 15 caused a sharp decline in yield. The latest seeding yielded best in only one year, 1922. Consequently, seeding

winter wheat either during the last half of September or the first part of October would seem to assure the best yields.

TABLE 18.—*Annual and average yields of winter wheat, spring wheat, oats, and barley sown on the dates specified for the years shown during the 6-year period from 1918 to 1923, inclusive*

Crop and date of seeding	Yields per acre (bushels)						
	1918	1919	1920	1921	1922	1923	Average
Winter wheat:							
August 1	52.9	3.8	33.9	22.8	26.2	20.0	26.6
August 15	53.3	9.4	40.9	21.7	37.2	20.4	30.5
September 1	55.3	9.6	43.2	24.0	33.8	26.8	32.1
September 15	55.1	9.5	42.7	28.0	36.4	33.4	34.2
October 1	57.2	9.8	47.9	25.8	44.1	29.6	35.7
October 15	54.2	7.3	37.5	24.4	44.8	23.6	32.0
November 1	46.8	5.0	30.6	8.8	50.6	7.4	24.9
Spring wheat:							
April 1	17.0	0	16.5	6.0	20.0	21.3	13.5
April 15	17.9	0	17.8	5.3	20.7	22.7	14.1
May 1	16.7	0	11.3	0	14.4	14.7	9.5
May 15	12.8	0	9.6	0	8.9	0	5.2
June 1	2.7	0	0	0	0	0	.5
June 15	0	0	0	0	0	0	0
Oats:							
April 1	38.4	0	34.6	------	------	------	24.3
April 15	39.4	0	29.2	------	------	------	22.9
May 1	40.8	0	31.7	------	------	------	24.2
May 15	38.8	0	24.2	------	------	------	21.0
June 1	7.3	0	12.5	------	------	------	6.6
June 15	9.2	0	5.5	------	------	------	4.9
Barley:							
April 1	25.5	0	41.7	------	------	------	22.4
April 15	27.7	0	31.1	------	------	------	19.6
May 1	28.9	0	29.7	------	------	------	19.5
May 15	27.1	0	13.6	------	------	------	13.6
June 1	20.1	0	8.6	------	------	------	9.6
June 15	10.4	0	------	------	------	------	------

With spring wheat, seeding later than April gave markedly lower yields than seeding in April, as shown in Table 18. Seeding later than May 15 resulted in a failure almost every year. With oats the April 1 seeding showed the highest average for the time the test was carried. The May 15 seeding averaged only 3.3 bushels less, but yields from later seedings were low. The results with barley compared very closely with those of oats, the April and early May seedings yielding best. The May 15 and June 1 seedings yielded well in 1918, however. In general, the results show that early seedings, not later than May 1, may be depended upon to give the best yields. Seedings later than May 1 with wheat and later than May 15 with oats and barley can not be depended upon to make paying crops.

EXPERIMENTS WITH FORAGE CROPS

Work with forage crops is conducted in cooperation with the Office of Forage-Crop Investigations of the Bureau of Plant Industry, United States Department of Agriculture. This consists of variety tests with alfalfa, sweet clover, sorgo, and field peas; methods of seeding alfalfa, sweet clover, and Sudan grass; and comparisons of the different forage crops.

ALFALFA

In 1917 a variety test with alfalfa was started, consisting of 12 known varieties and a lot of seed of unknown origin obtained locally.

Each variety was represented by one row 132 feet long, replicated three times in different parts of the field. At frequent but irregular intervals rows were seeded to the lot of local seed in order to provide a check on variations due to soil differences.

Owing apparently to local conditions of soil moisture at the time of seeding, the stands were not uniform in the different rows, and on that account the yields are not directly comparable. Consequently, no comparison of the different varieties on a yield basis is attempted in this bulletin. An important factor regarding this trial, however, is that there has been no noticeable winterkilling of any variety, and all seem to be about equally resistant to drought.

Grimm, the local seed used for checks, and the Kansas-grown seed were also included in another test seeded at the same time as the row test. Each of the three varieties was seeded in twentieth-acre plats, both in rows 35 inches apart and drilled with the grain drill, and each plat was replicated three times. Yields from this test are shown in Table 19.

TABLE 19.—*Annual and average yields of hay from three varieties of alfalfa, each seeded by two methods at the Sheridan Field Station for the six years from 1918 to 1923, inclusive*

Variety	Seeding method	Yields per acre (pounds)						
		1918	1919	1920	1921	1922	1923	Average
Grimm No. 178	35-inch rows	2,780	640	2,550	1,410	3,720	2,760	2,310
Do	7-inch drill	3,180	600	2,040	1,410	4,140	3,400	2,462
Average		2,980	620	2,295	1,410	3,930	3,080	2,386
Local seed	35-inch rows	2,760	640	1,890	1,090	2,540	2,180	1,850
Do	7-inch drill	2,940	360	2,130	1,370	2,940	2,820	2,093
Average		2,850	500	2,010	1,230	2,740	2,500	1,972
Kansas-grown No. 183	35-inch rows	3,100	700	1,830	1,550	3,160	2,580	2,153
Do	7-inch drill	3,460	300	2,350	1,050	3,060	2,320	2,090
Average		3,280	500	2,090	1,300	3,110	2,450	2,122
Average	35-inch rows	2,880	660	2,090	1,350	3,140	2,507	2,105
Do	7-inch drill	3,193	420	2,173	1,277	3,380	2,847	2,215

In this trial Grimm alfalfa averaged best, 2,310 pounds of hay per acre for the rows and 2,462 pounds for the drilled seeding. The plats grown from the local seed averaged 460 and 369 pounds less, respectively, and the yield from the Kansas-grown seed averaged 157 and 372 pounds less, respectively. None of the varieties in either trial winterkilled to any noticeable extent, and the killing out from drought appeared to be about the same with all varieties.

Experiments also were conducted with alfalfa in which three different methods of seeding were compared. Alfalfa was seeded in rows 35 inches apart and cultivated, drilled alone with the grain drill, and drilled with barley as a nurse crop. Seedings were made in 1917, 1920, 1921, and 1922. Table 20 shows the results by the different methods. No crop is produced in the first year, the year of seeding. Yields are shown separately for the second year, the third year, and the annual and average for each seeding from the first crop to 1923.

TABLE 20.—*Yields of hay per acre from alfalfa seeded by different methods at the Sheridan Field Station during the six years from 1918 to 1923, inclusive*

Crop, method, and year of seeding	Yields per acre (pounds)						
	1918	1919	1920	1921	1922	1923	Average
Second-year crop:							
35-inch rows	4,180			1,430	1,720	2,040	2,343
7-inch drill	3,200			760	800	2,000	1,690
7-inch drill with barley	2,620			490	0	2,320	1,358
Third-year crop:							
35-inch rows		440			4,420	2,200	2,353
7-inch drill		80			4,080	3,360	2,507
7-inch drill with barley		40			3,200	2,640	1,960
35-inch rows, seeded 1917	4,180	440	2,400	610	3,220	2,360	2,202
35-inch rows, seeded 1920				1,430	4,420	2,640	2,830
35-inch rows, seeded 1921					1,720	2,200	1,960
35-inch rows, seeded 1922						2,040	2,040
Average	4,180	440	2,400	1,020	3,120	2,310	2,245
7-inch drill, seeded 1917	3,200	80	2,380	230	3,160	2,220	1,878
7-inch drill, seeded 1920				760	4,080	3,140	2,660
7-inch drill, seeded 1921					800	3,360	2,080
7-inch drill, seeded 1922						2,000	2,000
Average	3,200	80	2,380	495	2,680	2,680	1,919
7-inch drill with barley, seeded 1917	2,620	40	2,760	610	3,980	3,040	2,175
7-inch drill with barley, seeded 1920				490	3,200	3,140	2,277
7-inch drill with barley, seeded 1921					0	2,640	1,320
7-inch drill with barley, seeded 1922						2,320	2,320
Average	2,620	40	2,760	550	2,393	2,785	1,858

The row seeding showed an undoubted advantage for the second year, the average yield for the years available for comparison being 2,343 pounds of hay per acre, as compared with 1,690 pounds for drilling alone and 1,358 pounds for drilling with a nurse crop. For the third year, however, the drilled seeding without a nurse crop had the highest average yield, over 2,500 pounds of hay per acre. This was about 150 pounds more than the yield from the rows and nearly 550 pounds more than from the seeding with a nurse crop.

Taking the average yields for the entire period, the rows averaged 326 pounds per acre more than the solid plantings sown without a nurse crop. The average difference between the yields from alfalfa drilled alone and that seeded with a nurse crop was only 61 pounds. The small extra yield from the rows can hardly be considered sufficient to warrant seeding the crop in this manner except for seed purposes. Seeding with a nurse crop almost invariably causes a lower yield of alfalfa the first year following seeding, but the yields thereafter seem to show little or no difference.

SWEET CLOVER

Sweet clover has not been an unqualified success as a forage crop. Heavy yields were secured in some years when there was a good stand, but in two years when growth probably would have been very good no crop was obtained, because dry weather the year before prevented a stand.

White sweet clover (*Melilotus alba*) seeded in rows 35 inches apart averaged 343 pounds per acre more than when drilled without a nurse crop. In two of the four years in which a crop was secured the

drilled seeding yielded the better. The yield of sweet clover seeded with a nurse crop approached that seeded alone in only one year of the four in which a crop was produced. It has been observed in other experiments that sweet clover seeded in the stubble without plowing has been as productive as that seeded on plowed ground.

TABLE 21.—*Annual and average yields of sweet-clover hay in variety and method-of-seeding tests at the Sheridan Field Station for the six years from 1918 to 1923, inclusive*

Variety and method of seeding	Yields per acre (pounds)						
	1918	1919	1920	1921	1922	1923	Average
White:							
35-inch rows	7,000	2,100	0	1,200	0	2,570	2,145
7-inch drill	5,420	2,200	0	560	0	2,630	1,802
7-inch drill with barley	1,680	800	0	166	0	2,490	856
Yellow:							
35-inch rows				1,570	0	3,720	
7-inch drill				865	0	4,680	

As shown in Table 21, yellow sweet clover (*Melilotus officinalis*) outyielded the white species in the years grown. It also produced the best quality of hay.

SORGHUM

The variety tests of sorghums included four varieties for the 7-year period from 1917 to 1923. Minnesota Amber was added in 1922. Table 22 shows the yields for each year and averages for the 7-year period. Red Amber leads with an average of 4,173 pounds of field-cured forage for the seven years. Dakota Amber averaged next best, 3,374 pounds per acre, but yielded best throughout the period from 1917 to 1921. Dakota Amber ripened seed almost every year that a crop was produced, but Red Amber ripened seed only in the longer seasons. Minnesota Amber produced next to Red Amber in 1922 and 1923 and ripened earlier. Considering the results for the full period that this test has been run, Dakota Amber appears to be the most dependable variety for all types of seasons. Red Amber and Minnesota Amber are heavier growing varieties and yielded much more in 1922 and 1923. In both years, however, there was more than the usual supply of moisture during the latter part of the season. Minnesota Amber was grown only in those two years, and its capacity for withstanding drought has not been tested at this station.

TABLE 22.—*Annual and average yields of forage from sorghums in variety tests at the Sheridan Field Station for the seven years from 1917 to 1923, inclusive*

Variety	Serial No.	Yields per acre (pounds)							
		1917	1918	1919	1920	1921	1922	1923	Average
Dakota Amber	[1] 105	3,000	4,740	0	4,230	1,050	5,580	5,020	3,374
Freed	[1] 162	2,500	4,340	0	3,270	1,050	5,330	6,030	3,217
Red Amber	[1] 174	2,540	4,660	0	3,370	870	9,900	7,870	4,173
White milo	[1] 181	2,060	3,060	0	3,000	450	5,780	6,480	2,976
Minnesota Amber	[2] 7038						7,920	7,580	

[1] Number assigned by the office of New and Rare Seed Distribution
[2] Number assigned by the office of Forage-Crop Investigations.

Sudan grass was grown each year by four methods—rows 42 inches apart, rows 35 inches apart, double rows 35 inches apart, and drilled with a grain drill. Table 23 shows the yields by the different methods. It will be noted that the row seedings were as complete failures in 1919 as the drilled seeding and that in 1921 the advantage over the drilled seeding was not sufficient to produce a profitable crop. With average yields of about 1 ton per acre for the entire period, the yield of the closest spaced rows was only 65 pounds per acre more than that of the drilled seeding, and that of the 42-inch rows was less. Ripe seed was secured in almost every year that a crop was produced. The results of seeding by different methods in larger fields in which Sudan grass was grown for feed confirm the results of the plat experiments.

TABLE 23.—*Annual and average yields of hay from Sudan grass seeded by different methods at the Sheridan Field Station for the years from 1917 to 1923, inclusive*

Seeding method	Yields per acre (pounds)							
	1917	1918	1919	1920	1921	1922	1923	Average
42-inch rows	820	2,660	0	2,330	490	3,550	3,260	1,873
35-inch rows	1,190	2,700	0	2,100	520	3,910	4,200	2,089
35-inch double rows	1,310	2,660	0	2,870	300	4,000	3,460	2,086
7-inch drill	890	3,140	0	2,370	260	4,150	3,340	2,021

MILLET

A limited variety test of millet was conducted from 1917 to 1923, inclusive, with the results shown in Table 24. The crop was a total failure in two of the seven years, but the yields were heavy in four of the other five years. Kursk averaged nearly 1½ tons per acre for the 7-year period. This is nearly 470 pounds more than Gold Mine, the next highest yielder. Siberian yielded highest in two of the three years it was grown.

TABLE 24.—*Annual and average yields of hay in variety tests of millet at the Sheridan Field Station for the seven years from 1917 to 1923, inclusive*

Variety	Serial No.	Yields per acre (pounds)							
		1917	1918	1919	1920	1921	1922	1923	Average
Kursk	[1] 160	0	3,400	0	4,800	1,720	6,660	4,260	2,977
Common	[2] 1429	0	3,200	0	3,970	1,280	5,140	3,740	2,476
Gold Mine	[3] 22491	0	3,800	0	4,330	1,380	3,700	4,360	2,510
Siberian	[1] 445	------	------	------	------	1,940	5,500	4,560	------

[1] Number assigned by the Office of New and Rare Seed Distribution.
[2] Number assigned by the Office of Forage-Crop Investigations.
[3] Number assigned by the Office of Foreign Seed and Plant Introduction.

FIELD PEAS

The work with field peas consisted of a trial of four varieties from 1917 to 1923, inclusive, and one other variety in 1922 and 1923. The peas were sown in close drills in twentieth-acre plats replicated three times. Beginning with 1920 one variety also was grown in double

rows 35 inches apart, and the variety added in 1922 was grown by that method as well as in the drilled plats. The peas were harvested when mature. The results are given in Table 25.

TABLE 25.—*Annual and average yields of field peas at the Sheridan Field Station for the seven years from 1917 to 1923, inclusive*

Seeding method and variety	Yields per acre (bushels)							
	1917	1918	1919	1920	1921	1922	1923	Average
Drilled:								
Kaiser	5.2	6.8	0	5.7	0	13.2	7.4	5.5
Golden Vine	2.5	3.8	0	5.6	0	10.7	4.7	3.9
Paragon	3.3	7.5	0	6.2	0	11.4	7.4	5.1
Carleton	2.6	10.2	0	5.8	0	11.2	7.3	5.3
Bangalia						17.2	9.1	
Double rows:								
Carleton				5.5	0	7.6	5.1	
Bangalia						13.3	2.7	

Kaiser had slightly the highest average yield for the 7-year period, 5.5 bushels per acre, but this was only 0.2 bushel more than the yield of Carleton and 0.4 bushel more than that of Paragon. Bangalia in close drills outyielded all other varieties by a considerable margin in 1922 and 1923, the two years it was grown. This is an early variety. Carleton was grown in rows and in close drills for four years and Bangalia for two years. The rows did not yield as heavily as the close drills.

In 1921, 1922, and 1923 a mixture of field peas and oats was grown for hay. The yield of the mixture was low in comparison with that of other crops, the average for three years being only 1,773 pounds per acre.

The yield of straw from the field peas in the variety test was determined each year except 1920. The 6-year average yield per acre, including one year of total failure, was Kaiser, 1,008 pounds; Paragon, 945 pounds; Carleton, 895 pounds; and Golden Vine, 793 pounds.

EXPERIMENTS WITH POTATOES

Work with potato varieties was begun in 1918. A number of varieties were planted that year, but in 1919 the crop was a total failure, and the seed of all varieties was lost. Seed of four of the varieties was again procured in 1920. Two of these were discontinued in 1922, but one of those discontinued was planted again in 1923. The yields of the four varieties are shown in Table 26. Of the two varieties grown every year, Triumph averaged 64.8 bushels per acre for the 6-year period, or 8.1 bushels more than Early Ohio. This trial generally was conducted on as light land as was available at the station. With miscellaneous plantings on heavy soil Early Ohio generally outyielded Triumph. On the heavier land not as many potatoes were formed with the Early Ohio as with the Triumph, but their growth was better.

Another experiment was conducted with potatoes in which the seed was planted three distances apart in the row, 18, 24, and 30 inches. Triumph seed was used the first two years and Early Ohio the other four years. The yields are shown in Table 26. The

thickest planting yielded best in three of the five years in which there was a crop, but the average for the entire period was only 1.6 bushels more than from the 24-inch planting, the average yield of the 18-inch planting being 63.5 bushels per acre. The yield of the 30-inch planting was decidedly less than the yields of the thicker plantings.

TABLE 26.—*Annual and average yields of potatoes in variety and rate-of-planting tests at the Sheridan Field Station for the six years from 1918 to 1923, inclusive*

Variety and spacing	Yields per acre (bushels)						
	1918	1919	1920	1921	1922	1923	Average
Variety:							
Early Ohio	74.7	0	41.7	11.0	113.0	100.0	56.7
Triumph	103.9	0	41.7	0	129.3	114.0	64.8
Irish Cobbler	65.5	0	33.0	6.0	--------	39.8	--------
Pink eye	85.0	0	58.3	7.5	--------	--------	--------
Spacing in row:							
18 inches	86.7	0	33.3	9.5	151.2	100.5	63.5
24 inches	103.9	0	31.7	11.0	136.2	88.5	61.9
30 inches	82.6	0	31.7	7.5	127.8	63.0	52.1

SHELTER-BELT INVESTIGATIONS

A strip of ground 80 feet wide and 1,000 feet long on the west side of the station grounds and immediately west of the buildings was planted to trees for a shelter belt in 1917 in two equal blocks. The north block was planted with the trees 4 feet apart each way and the south block with the trees 4 feet apart in the rows and the rows 8 feet apart. The two blocks are known as the 4 by 4 and the 4 by 8 blocks, respectively. This shelter belt was planted in cooperation with the Northern Great Plains Field Station, Mandan, N. Dak. Seedling trees were supplied by that station, and the planting was made according to plans furnished by it.

The trees in each block were planted in rows in order from east to west as follows:

South block, 4 by 8 feet.—Golden willow, boxelder, Chinese elm, Chinese elm, green ash, boxelder, American elm, poplar, boxelder, golden willow.

North block, 4 by 4 feet.—Golden willow, green ash, boxelder, green ash, poplar, green ash, Chinese elm, poplar, boxelder, poplar, green ash, boxelder, Chinese elm, boxelder, poplar, green ash, boxelder, golden willow, golden willow.

A drainage course crosses the block near the center. A clean cultivated strip about 30 feet wide was left next to the willows on the east side, but on the west side native grass came to within 4 feet of the outside row. The first (east) row of Chinese elms in the 4 by 8 block was taken out in 1918 and replanted to poplar, but the poplar failed to survive. This leaves a space 16 feet wide between the box elder and the remaining row of Chinese elms.

Clean cultivation has been practiced since the shelter belt was planted, but the growth had become too thick in the 4 by 4 planting to allow further cultivation after growth started in 1923, except where rows had killed out.

No northwest poplars were included in this planting, Norway poplar being used. Many of these died each year. Those remaining made a rapid growth, but nearly all, except some of those in the drainage course, died in the spring of 1921. Practically all the wil-

lows killed back and many died each year until 1920. Those remaining on the east side have since made a good growth with little killing back, but practically all of those on the west, except in the drainage course, died in 1921 and 1922 and were pulled out in the fall of 1922. This now leaves a strip of clean cultivated land about 12 feet wide on the west side.

Boxelders, except in the row farthest east, killed back badly in the winter and spring of 1921 and 1922, probably from drying winds and lack of moisture in the spring. Growth in the 4 by 4 block was shorter and killed slightly less than in the 4 by 8 block. Very little killing back was evident, however, in the boxelder row with the 16-foot space between it and the next row. Chinese elm has made the fastest growth of any sort and has killed back but little. American elm has killed but little more, but growth has been slow. Ash has not killed back noticeably, but has grown very slowly.

Evergreens of different species were planted each year in a row 16 feet from the willows on the east side, but until the planting of 1922 only a few lived through the summer. In 1922 the seedlings were shaded with shingles and most of them survived.

Additional plantings were made in 1921 and 1922, which included Chinese elm, boxelder, ash, buffaloberry, Russian wild olive, and Siberian pea-tree. No killing back or dying out has been evident with these plantings. The spacing distances include 6 by 8 feet, 8 by 8 feet, 8 by 12 feet, and 12 by 12 feet, making six different spacings now being tried for trees in the shelter belt.

SUMMARY

The results of work with crop rotations and tillage methods over a period of six years; with varieties of grain and forage crops, rates and dates of seeding grain crops, and methods of seeding forage crops over a 7-year period; experiments with potatoes; and shelter-belt investigations are reported in this bulletin.

The rainfall records and the seasonal variations in yield show the seasonal rainfall to be the chief controlling factor in crop production over this area, but attempts to overcome the controlling influence of rainfall by means of cultural practices have met with limited success. The investigations do not show any cropping method that may be depended upon to insure a good crop every year, but substantial differences are shown between different methods, and good average yields are obtained by the better practices.

Material differences in yield between crops on fall plowing and those on spring plowing are shown in some years. Over a period of years, however, the average differences are too small to be of more than minor importance provided that seeding is not unduly delayed by the spring plowing.

Yields of small grain on corn ground were slightly greater than on land in small grain the previous year. Yields of spring grain on corn ground averaged only slightly lower than on fallow. Raising grain crops on disked corn ground is one of the cheapest methods of production. The yields on disked corn ground are practically as great as on plowed corn ground. The feed value per acre of corn, including the stover, is as great as that of any of the grain crops. Consequently, it appears that corn should have a definite place in any system of crop production for this area.

Fair yields of winter wheat may be expected on fallow even in the dry years.

The yields of spring grains are more certain on fallow than following small grain or corn, but the increases are not as large as with winter wheat.

Fallow plowed about the time of plowing for corn produced higher yields than plowing either later or in the previous fall.

The application of barnyard manure did not increase yields noticeably. The use of a green manure is entirely unjustifiable, as it increases the expense without increasing the yield.

Kharkof was the highest yielding winter wheat tested. No variety of spring wheat outyielded Marquis sufficiently to warrant replacing that variety. Kota yielded better than Marquis in 1921, 1922, and 1923, but has not been grown long enough to establish its value for general use in this section.

The early oats of the Sixty-Day type yielded best in dry years, whereas the later or midseason varieties were best in other years. Trebi, a 6-rowed variety, was the highest yielding barley tested.

Northwestern and Payne White, early varieties of dent corn, matured fully ripe corn each year except in 1919, when the drought was so severe that none of the varieties made a crop. Later varieties, such as Minnesota No. 13, produced larger yields of fodder but often failed to mature. Early varieties of flint corn produce well and are valuable for hogging off.

Seeding winter wheat late in September or early in October at about 1 bushel per acre gave the best results. The best yields of spring grain were secured by seeding in April at the rate of about 4 pecks per acre or even slightly less.

Sorgo was the highest yielding forage crop. The effect of sorgo on succeeding grain crops has not been fully determined.

Alfalfa, millet, and Sudan grass were grown successfully. Seeding alfalfa and Sudan grass with the grain drill gave fully as good results as seeding in rows.

Field peas did not yield heavily enough to make this crop a successful one.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

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